Case Study 159

Energy efficient lighting in factories

**Romford Brewery Co Ltd,
Romford, Essex**

- Upgrade system cuts installed load by 50%
- Electricity consumption and costs cut by 66%
- Overall payback on investment of less than 2.5 years
- 40% saving on maintenance costs
- Effective use of automatic controls

Why modernisation offers great savings potential

Owners of industrial lighting systems that are more than a few years old would do well to investigate the potential savings they could achieve from modernisation. Many are likely to find that the cost of implementation would be recovered within two or three years by consequent savings on their electricity bills.

Recent developments have led to the introduction of lamps and luminaires that offer dramatic improvements in energy efficiency, so modernisation could be just a question of fitting replacement components.

It is also likely to involve the use of automatic control systems with light and/or proximity sensors and time switches. These provide savings by avoiding the use of artificial lighting when available daylight is sufficient, or when people are absent.

If there have been any significant alterations in a building's structure, its contents or the way it is used, then a completely new system may be called for, but the costs may still be recovered within two or three years.

Exterior view

Summary

This Case Study concerns a brewery that was spending about £35 000/year on electricity for lighting in its brewing and fermentation building. Following rationalisation and modernisation of the system in 1990/91, this company is now **saving** £35 000/year on its overheads (about £22 000 from reduced electricity bills, and the rest from savings on related maintenance costs). This gives a payback on the total investment of less than 2.5 years.

The original lighting system had been left virtually unchanged when substantial alterations were made to the plant and building structure in the late 1970s/early 1980s. This meant that a large number of the luminaires (light fittings) were either in places where they were no longer needed, or so obscured (by components of the new plant) that their output was of little value, or so difficult to gain access to, that cleaning and lamp replacement was seldom, if ever, done.

Compensating for these deficiencies, the desired lighting levels were regained, where necessary by adding luminaires to existing circuits. The lighting load climbed steeply therefore with no improvement on the

"Brewery saves lighting costs of £22 000 per year for electricity and £13 000 per year for maintenance"

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original output. But even if there had been no changes made to the building or plant, and the original lighting system had been maintained in perfect order, it would still have been a prime candidate for modernisation because of its age (see box on front cover).

There was nothing extraordinary about the measures that were taken, but the description that follows of the changes that were made to the lighting system may offer some useful pointers to others on what can be done.

Background

Romford Brewery Company has been making beer at its present site in Essex for over 200 years. The largest structure on the site is the four-storey brewing and fermentation building, which was substantially altered in the late 1970s and early 1980s to accommodate new processing plant.

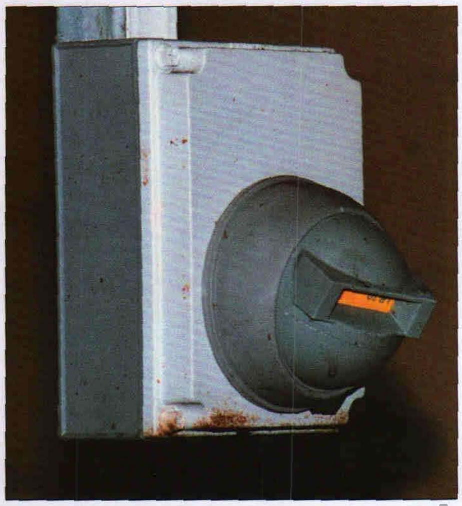
The building occupies a site of approximately 10 000 m^2, and it is divided into 147 separate areas of greatly differing shapes and sizes. Only the upper two floors and main stairways have windows or skylights, and processing areas on the lower floors get no daylight. With central control room monitoring, most of these processing areas are left unmanned for long periods, so electric lighting is seldom required, but in practice it was left on for most of the time.

The need for change

An energy survey in 1989 drew attention to the excessive use of electricity for lighting in the building, which was then costing the company about £35 000/year. A lighting audit, commissioned as a result of the energy survey, recorded the condition, switching arrangements and usage of all luminaires in the building, and confirmed the potential for a major reduction in costs.

The audit revealed that most of the luminaires were 38 mm diameter fluorescent tubes, with wire-wound control gear and glow starters.

Some lamps and luminaires were in poor condition or had failed, and needed replacement. These included some that were in locations where erection of a scaffold was needed to gain access. Other luminaires served no useful purpose, being badly positioned, with new or relocated plant completely obstructing their light. Maintenance was not planned, and lamps were replaced only on complaint.



Ultrasonic sensor

Interior view

Calculations for each area of the building, carried out as part of the audit, showed that in many cases the number and size of luminaires was far greater than they should have been to achieve the illuminance levels recommended in the CIBSE Code for Interior Lighting.

Actions taken

Responding to the findings of the audit, the following six-point action plan was implemented:

- reduce the number of luminaires
- use more energy efficient luminaires
- use more energy efficient lamps
- renew all faulty or deteriorated luminaires
- fit automatic control systems
- initiate a planned maintenance schedule.

As a result, all existing luminaires which were not fulfilling a requirement have been removed or repositioned, and all faulty, dilapidated, obsolete or oversized luminaires have been replaced or upgraded. The total number of units installed was reduced by 337, from 1382 to 1045.

All 38 mm diameter fluorescent tubes of 65 W and 20 W were replaced by more efficient 26 mm diameter tubes of 58 W and 18 W respectively. These slimmer lamps produce approximately the same light output as the larger lamps they replaced, but consume about 8% less electricity. (Further savings of 20% or more could have been obtained with these lamps if their wire-wound control gear had been replaced by high frequency electronic circuits.) Most tungsten lamps were replaced by compact fluorescent lamps. They have a much longer life, and require about 70% less power to provide a comparable output. Other changes included replacement of all high pressure mercury discharge lamps (which are inefficient by present day standards) by fluorescent fittings or high pressure sodium lamps. The end result of all these changes was a reduction of over 50% in the installed power load for lighting - down from 164 kW to 81 kW.

In order to minimise start-up time, plug-in electronic starters replaced the glow starters in all fluorescent luminaires that were retained, and all new fluorescent luminaires had built-in electronic starters. This is an essential requirement for operation with occupancy sensor control systems, which were being installed in many areas as part of the refurbishment.

Some fluorescent luminaires were fitted with standby battery power supplies so that, in addition to their regular use with mains power, they could provide emergency lighting when the mains failed. All these luminaires are clearly labelled, and undergo regular function tests in accordance with BS 5266 requirements for emergency lighting.

Where appropriate, luminaires made from corrosion-resistant materials and sealed against ingress of dirt and moisture were specified.

Industrial lighting

Industrial lighting should provide sufficient light in the right place at the right time. It should enable people to see what they need to see easily and in comfort, and allow them to perform their work safely, efficiently and with minimum visual strain.

In processing plants, it is usually necessary to tailor each installation to the particular needs, not just of the overall complex, but of each particular part. The bulk and complexity of the plant in most cases will rule out anything resembling a regular array of luminaires, and special precautions must often be taken against wet, dirty, corrosive and/or hazardous environments.

Processing plants are also likely to have areas that are left unmanned for long periods. The use of control systems with proximity sensors, which raise the level of lighting from pilot to task illuminance when people are present, can make a major contribution to energy saving in this situation.

Efficient electric lighting is seldom achieved simply by choosing the lamp which converts the most energy to light output, especially if the colour is inappropriate to the visual task. Nor is it necessarily achieved by gathering all the light output and directing this towards a horizontal plane at benchtop height. Work in factories is frequently carried out on various planes and levels. Light which reaches non-working surfaces, in particular walls and ceilings, can have the important advantage of improving appearance and vision, and reducing glare.

The majority of luminaires were tubular fluorescent types. High pressure sodium lamps had already been installed in both the more spacious areas and those where manning periods were extended; these were incorporated into the scheme. Fluorescent luminaires with standby power supplies were added in these areas to function as pilot lights, and to provide illumination when there is a mains failure. These luminaires are switched on continuously.

Importance of lighting controls

Lighting control systems were chosen to suit the work functions of each area and ensure sufficient light for safe movement, either by daylight or electric lighting. An appropriate daylight-linked control system for this installation uses photocells to detect the availability of daylight, and adjusts the level of artificial lighting accordingly. (It is not always necessary to use photocell control to take advantage of daylight – see BRE Digest 272.)

Where appropriate, occupancy sensors are used to detect movement of personnel in an area, and cause illuminance to be raised (or lowered when there is nobody present) to predetermined levels. Most of these sensors use infra-red detectors, because these are effective and inexpensive. Where obstructions in the space prevent their use, microwave detectors are used; these can cost five times as much but can 'see' around corners, to some extent.

Manual switches are used in working areas which are infrequently occupied, and where presence sensors are not suitable, eg where entry may be from any number of places or the motion of equipment may activate the switching. The switches are push-button types with an in-built timing facility which can be adjusted to set the lighting period. The lighting period after the sensor or timed switch has been activated was adjusted to allow normal work to be carried out, plus a safety margin of up to 30 minutes.

Ordinary manual on/off switches are installed on some stairs and access ways which are used frequently, and in working areas which are occupied for long periods.

All the automatic switching devices have key-operated override switches to operate the lights for longer periods, such as when servicing the plant, or to isolate the electrical circuit when working on the wiring.

The use of automatic lighting control systems, selected to suit the needs of each area of the building, combined with instruction of the workers on how the systems work, made a major contribution to the energy and cost savings achieved by the refurbished installation.

Energy related cost savings

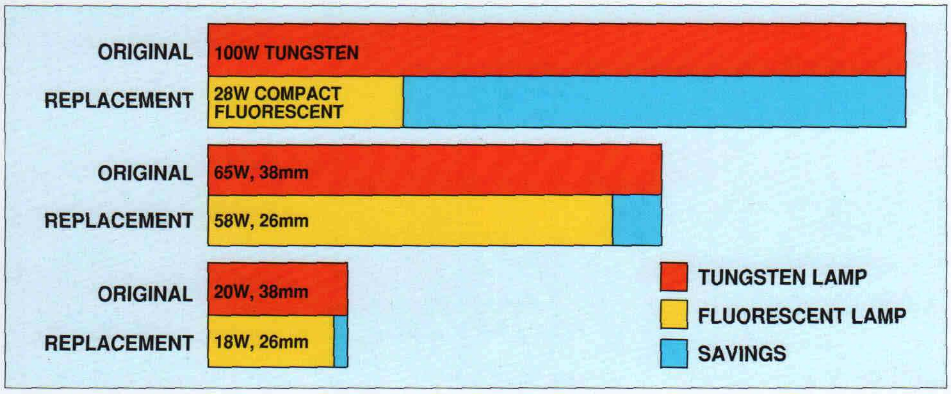
Estimated electricity cost savings (based on sample monitored data) of £22 700/year have been achieved by reducing the installed load by over 50%, and by using automatic control systems to reduce running time of the remaining luminaires - see table 1. The installed load was cut mainly by removing unnecessary or over-sized luminaires, and fitting high energy efficiency replacement lamps wherever possible.

Energy related savings (annual basis)

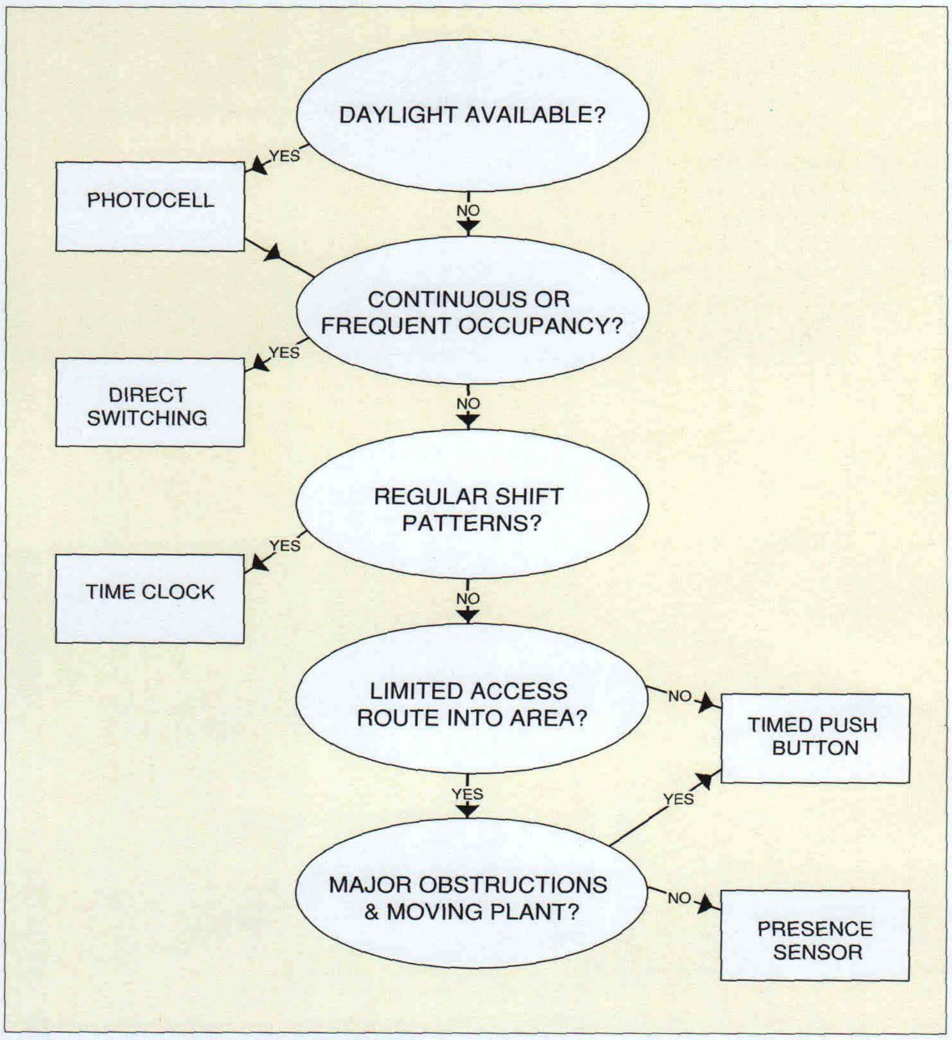
	Installed load (kW)	Energy consumption (kWh)	Electricity cost at 5 p/kWh (£)	CO_2 production (tonnes carbon)*
Original system	164	984 000	34 400	758
New system	81	334 500	11 700	258
Savings	83	649 500	22 700	500

* CO_2 (carbon dioxide) is a major contributor to global warming (greenhouse effect).

Table 1 Energy related savings



Savings achieved by replacing existing lamps with higher efficiency types that provide comparable light output



Lighting control methods

Planned maintenance schedule

Efficient lighting performance requires luminaires to be cleaned and kept in working order, and lamps replaced at the end of their useful life, which is usually before failure occurs. A planned maintenance schedule has therefore been implemented, with fluorescent and sodium lamps being replaced after 8000 hours use, and all luminaires being cleaned every six months.

Experience has shown that easy maintenance is essential, so wherever possible the luminaires have been made accessible (without the use of a scaffold) for cleaning and lamp replacement, and easily removable for repairs. Most can be disconnected by means of a plug and socket, and unhooked for workshop rather than on-site repair.

For planned lamp replacement, the hours run must be known, and this is more difficult where sensors are employed. Since pilot lights are always in use, these have been identified by clear labelling to assist timely replacement. The maintenance schedule of the other luminaires is established through hours-run meters incorporated into the area lighting control panels.

The planned maintenance schedule keeps the installation efficient. This, combined with the reduction in the number of luminaires and improved accessibility, is judged to have cut maintenance costs by about £10 000/year. In addition, by using controls to shorten the time that lamps are lit, further savings worth about £2400 are made from reduced labour and component replacement costs. Altogether, these savings come to £12 400, which is about 40% of the estimated original maintenance cost.

User and owner reactions

The operatives appreciated the improved lighting conditions. They had been made aware of the need to conserve energy, and were supportive of the efforts being made, providing safety was not compromised. Although some said they would prefer to enter a fully lit room, the short delay while the lights were switched on was not seen as a problem. The only complaints concerned glare in the filter room, caused by reflections from polished stainless steel equipment after high pressure sodium lighting had replaced tubular fluorescent in this area. Action is being taken to deal with this problem.

The owners are extremely pleased with the improved lighting conditions in the building, and with the financial return they are getting on their investment.

Conclusions

The lighting standards have not been compromised by the steps taken to save energy. In many areas of the building, the lighting has been improved by relating the positions of the luminaires to the operations being performed.

The installed load has been reduced by over 50%, and 30% of the energy that would formerly have been consumed by the reduced installed load is being saved by the use of automatic switching, based on daylight and zone occupancy sensing.

The total estimated annual energy savings amount to almost 650 000 kWh, which is equivalent to 500 tonnes carbon dioxide emission. So as well as saving energy and money, there is a significant benefit to the environment.

Total annual cost savings amount to £35 000 (£22 700 on electricity and £12 400 on maintenance), and the total installation cost was £75 000, giving a payback period of less than 2.5 years.

In order to achieve these savings, it is of course essential for automatic controls to be correctly adjusted, with minimum delay in rectifying faults, and for the entire lighting system to be well maintained. A specification is being prepared with a view to employing a specialist lighting maintenance contractor to take over this responsibility.

Further information

This Case Study is one of a series that gives details on energy efficient lighting in a variety of industrial situations. Further information (on standards to aim for, savings possibilities and how to achieve them) can be found in the following documents.

- BRE Digest 272
  Lighting controls and daylight use
- CIBSE Code for Interior Lighting
- CIBSE Lighting Guide (G), Industrial Buildings
- LIF (Lighting Industry Federation) Energy Managers Lighting Handbook
- HSE (Health & Safety Executive) publication: Lighting for work

EEO publications, available from BRECSU

- ECON 18 Energy efficiency in industrial buildings and sites
- ECON 19 Energy efficiency in offices
- GPG 61 Design Manual: Energy efficiency in advance factory units
- GPG 62 Occupiers Manual: Energy efficiency in advance factory units

THERMIE

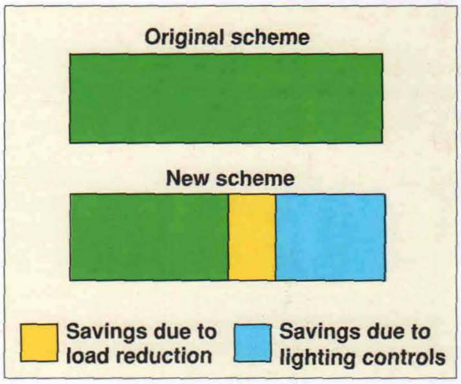
- Thermie Maxibrochure: Energy efficient lighting in industrial buildings

New developments

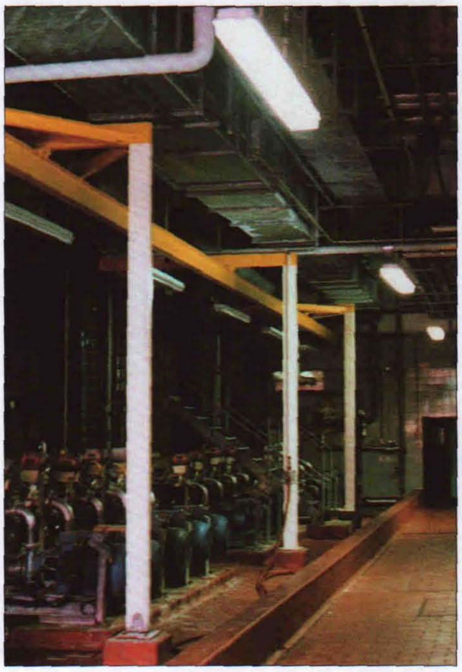
The 1994 CIBSE Code for Interior Lighting recommends lighting levels in terms of maintained illuminance, rather than service illuminance. Work is progressing on a number of other European documents that are expected to contain new regulations and/or recommendation relating to lighting. These developments have no affect on the validity of the energy efficiency measures described in this Case Study, but they will have to be taken into account on future projects.

Acknowledgments

The information presented in this series of Case Studies has been taken from material provided by users and from site visits carried out by independent consultants. The cooperation of the owners, designers, managers and occupants of the Case Study building is gratefully acknowledged.



Energy consumption and savings



Area with pilot lighting only

Area with working light

HMSO. Dd. 8433765, 4/94, C50, 38938